NOTES

ON THE

PROPAGATION AND CULTIVATION

OF THE

MEDICINAL CINCHONAS

OR

PERUVIAN BARK TREES.

Printed and Published by Order of the Government of Madras.

BY

WILLIAM GRAHAM McIVOR,

SUPERINTENDENT GOVERNMENT CINCHONA PLANTATIONS, NEILGHERRIES.

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CONTENTS.

	PARA.
Preface	1
Sites, Selection of, for Plantations.	2
Sites, Aspect of	3
Sites, Rainfall	4
Sites, Elevation, Temperature, &c.	5
Plants, management of, on their receipt in Wardian cases.	6
Propagation, importance of	7
Propagation by Seeds	8
Propagation by Layers	9
Propagation by Cuttings	10
Propagating House	*ib.*
Management of Cuttings	11
Buds, propagation by	12
Buds, preparation of	13
Nurseries, formation of, in open air	14
Nurseries, preparation of	15
Nurseries, planting of	16
Cultivation, review of methods recommended	17
Cultivation, preparation of sites	18
Plantations, laying out of	19
Plantations, planting of	20
Plantations, remunerative prospects of	21
Bark, first harvest of in five or six years	*ib.*
Bark grown on the Neilgherries, analysis of	*ib.*
Bark, cost of production incomparably under market value of	22
Species yielding Quinine introduced into India, notice of	23
Cinchona Succirubra	*ib.*
Cinchona Calisaya	*ib.*
Cinchona Uritusinga	*ib.*
Cinchona Condaminea	*ib.*
Cinchona Crespilla	*ib.*
Cinchona Lancifolia	*ib.*
Species yielding Cinchonine	*ib.*
Species Nitida	24
Species Ignota	*ib.*
Species Micrantha	*ib.*
Species Peruviana	*ib.*
	ib.
[illegible] of plants	25

LIST OF ILLUSTRATIONS.

	PLATE.
Propagation by Layers	I
Plan of a Propagating House	II
Propagation by Cuttings and Buds	III
Formation of Nursery Beds	IV
Temporary Shading	V
System of lopping and pruning recommended	VI

NOTES

ON THE

PROPAGATION AND CULTIVATION OF THE MEDICINAL CINCHONAS OR PERUVIAN BARK TREES.

1. In submitting to the public a brief outline of our experience in the propagation and cultivation of these valuable plants, I would observe that I do not presume to furnish a perfect guide to their management, as little indeed is yet correctly known of the requirements of the plants under cultivation. My object is merely to place in the hands of all who are interested in the extension and increase of this valuable product, a knowledge of the management of the plants in their earlier stages, or up to the period to which our experience in their cultivation extends. The Government of Madras has already placed the Cinchonas within the reach of the general public, by authorising the distribution of the plants at the moderate rate of 4 annas each; it however has been felt that the distribution of the plants might in many instances lead to disappointment and failure, if unaccompanied by instructions for their cultivation and management.

2. *Selection of sites for Plantations.*—This is perhaps the most important task which has to be performed, as much of the future success of the plantations will depend on the suitability of the sites selected. In the first instance, the Cinchonas require rich forest land, the surface soil consisting of an open black or chocolate colored loam of from two to three feet in depth, resting upon an open sub-soil, in order to give efficient drainage, as nothing is so injurious to Cinchonas as stagnant water at the roots; therefore any land with a retentive sub-soil is altogether unsuited to their growth. The site must be well sheltered from prevailing winds; the necessity for this arises from the leaves of the red and grey barks being so large and tender when young, that heavy gales of wind act on them with such force as not only to break and damage the leaves themselves, but to twist and seriously injure the plants. The yellow and crown barks, being small leaved species, bear the

wind better, and would grow in more exposed situations; a certain amount of shelter however is desirable for the successful cultivation of all the species.

3. *Sites, Aspect.*—The aspect of the plantations should be North, or North-West; a North-East exposure will also be found suitable where the winds accompanying this monsoon are not severe. The reason why a Northern exposure in these latitudes is beneficial, is from the fact that it is much more moist during the dry season, than a Southern aspect; because the sun's declination is Southerly during our dry and cloudless season of the year, and thus on the Northern slope, the rays of the sun do not penetrate and parch the soil. A Northern aspect has also the advantage of preserving a much more uniform temperature than a Southern aspect, because the excessive radiation and evaporation on the Southern slopes greatly reduces the temperature at night, while in the day they are heated to excess by the action of the sun's rays striking the surface at nearly right angles. The practical effects of aspect on the plants are so great, that they cannot be overlooked with impunity, and in order to impress this upon the minds of all who may have the selection of localities for Cinchona cultivation, I mention that the difference of temperature is almost incredible; for example, at this elevation, a thermometer laid on the surface of the Southern face of a hill exposed to the sun at 3 P. M. will frequently indicate from 130° to 160° Fahr.: the same thermometer if left in its position and examined at 6 A. M. will generally be observed to indicate from 30° to 40° Fahr.: while on a similar slope if selected with a Northern aspect, the thermometer under the same circumstances at 3 P. M. will generally indicate 70° to 80° Fahr., and at 6 A. M. from 40° to 50° Fahr. All authors agree that Cinchonas delight in an equable temperature; and this has been unmistakably established by the plants themselves under cultivation: the vital importance of aspect is therefore fully explained. While on this subject, it should be observed that a hollow or land-locked valley is also unsuitable to the cultivation of Cinchonas, because the cold air generated at night on the sides of the neighbouring hills, being of greater specific gravity than the warm air, rolls down and fills the valley, displacing the warm air and reducing the temperature of the valley to a degree injurious to the Cinchonas.

4. *Sites, Rainfall.*—A moderate amount of rain (from 60 to 100 inches in the year) falling uniformly in showers at not too great intervals, is most beneficial for the growth of Cinchonas; they delight above all things in showers and sunshine; this has been clearly illustrated by the rapid growth, and fine healthy appearance which the plants assumed at Neddivuttum, during

he showery months of October and November. Long continued rain is decidedly injurious to the health of the plants, as also continued drought, but of the two, the latter is to be preferred, as the plants thrive well under artificial irrigation.

5. *Elevations.*—The best range from 4,500 to 7,500 feet, but different species require different elevations. Our experience, indicating 4,500 to 6,000 feet as best suited for the 'red', 'yellow', and 'grey', barks, and their varieties; while from 5,000 to 7,500 feet, promises to be most favorable for the varieties of the "Crown bark." These elevations are named from our observations on the Neilgherries, where an altitude of 4,500 feet in a sheltered locality, gives a mean temperature of about 66° Fahr.: 6,000 feet giving a mean temperature of 59° Fahr., and 7,500 feet giving a mean temperature of about 53° Fahr. It may be mentioned that the temperature of any given locality is a more certain guide than elevation.

6. *Plants in Wardian cases.*—In introducing the subject of cultivation, I take the opportunity of impressing upon all who may receive Cinchona plants in Wardian cases, the desirableness of placing them in the first instance under the protection of glass. If this be not available, the cases should be placed in a shady position, and opened only so much at a time as the plants will bear without flagging. So soon as the leaves of the plants are observed to flag, or droop, the cases should be immediately closed, and great care taken not to give the plants too much water at the roots, as this is apt to cause them to rot; in fact, the soil at the roots should always be kept rather dry than otherwise, the supply of moisture being kept up in the plant by frequently sprinkling the leaves with water. This treatment is only necessary until the roots assume a healthy and vigorous action, which will take place in from eight to twenty days, according to the length of time the plants have been confined in the Wardian cases.

7. *Propagation.*—It is of the utmost importance that a correct knowledge should be disseminated of the principles of propagation, as the increase and multiplication of every valuable plant forms an object of the utmost utility, as by such means only they can be produced in quantities sufficient fairly to test their advantages to mankind, and their commercial value. The Cinchonas are propagated by seeds, layers, cuttings, and buds.

8. *Propagation by Seeds.*—The Cinchona seeds previous to being sown should be steeped in cold water for about six or eight hours. As the seeds are very small, when removed from the water (which is effected by pouring

both seeds and water into a muslin strainer) they should be mixed with their own bulk of fine dry sand, or powdered charcoal. The only difficulty in the successful management of Cinchona seeds is their impatience of any excess of moisture, and therefore it has been found necessary to take some trouble in the preparation of the soil for their reception; the method which we have pursued with the greatest advantage being as follows :—The soil used being composed of leaf mould, or the earth produced by rotten leaves, was sifted and mixed with four times its own volume of sand. The leaf mould was in the first instance exposed to the sun for two or three days, and thoroughly dried; it was then heated to about 212° Fahr., in order to destroy all grubs or larva of insects: after being allowed to cool, it was brought into the potting shed and watered sufficiently to make it moist, but only to that degree of moisture that the particles of soil would not adhere together when pressed firmly with the hand, that is, the earth on being laid down was sufficiently dry to break and fall into its usual form. The leaf mould and sand in this state of moisture were mixed together, and the pots filled; the surface lightly pressed down, and the seeds sown thereon being covered with a sprinkling of sand. The pots were then plunged into beds of moist sand on a bottom heat of about 75° Fahr.: these were never watered in the strict sense of the word; when the surface became dry, they were merely sprinkled with a fine syringe, just sufficient water being given to damp the surface, but never to penetrate or consolidate the soil; under this treatment the seeds began to germinate very strongly on the 16th day after sowing. The principal art appears to be to keep the soil in an uniform state of moisture, but never wet. The least excess of moisture causes the seeds to mould and damp off in thousands, while as a matter of course, if kept too dry, they become parched up. As soon as the seeds germinate, they are carefully pricked out into fresh earth (prepared as above described) this operation is a very delicate one; the radicle being carefully raised with a small pointed stick out of the original seed-pot, is removed to the new pot, and covered with soil, while the seed lobes are kept well above the surface. In this way from twenty-five to fifty seedlings are transplanted into a five-inch pot, and then treated in every respect the same as the seeds, that is, they are never watered, the surface being merely sprinkled and the pots plunged in beds of damp sand, as before stated, to keep the soil in that medium state of moisture in which it was when first placed in the pots. The necessity for this care is to prevent the seedlings from damping off, to which they are very liable when treated otherwise; it also greatly facilitates their growth and the formation of roots, the earth in which they are placed being so perfectly open that it is readily affected by the action of the atmosphere, and thus kept in the most

favorable condition for promoting vegetation. When treated in this way, our seedlings have made an average growth in one year of over thirty inches, while many of our seedlings which were raised and grown on a retentive soil have not attained the height of three inches in the same period.

9. *Propagation by Layers.*—As soon as the plants have attained a height of from 10 to 15 inches, they are propagated by being layered as illustrated in Plate I; in this way they were found to root readily in about six weeks, or two months at the latest, and the plants by being bent down, break or throw out shoots from every bud along the whole length of the stem, and not only this, but many latent buds are developed and a fine growth of young wood produced for succeeding layers and cuttings; in this way each branch or shoot is treated as it gains sufficient size. The principle of layering we have adopted is somewhat different from that usually practised, as we found when cut, the juice of the Cinchonas flowed so freely from the wound that if merely placed in the soil, it was apt to cause mildew and rot. To remedy this, a piece of perfectly dry brick is placed into the cut as soon as it is made; this absorbs the juice and effectually prevents the ill effects above mentioned. The layers when well rooted are removed from the parent plant, potted off, and kept in a close atmosphere for a few days until they become established. In removing the layers, great care must be taken; for if they are cut off before the shoots shown in Figure 2 at A and B have attained a good size, and their leaves fairly developed, the stock or parent plant is almost certain to die off. The reason of this is, the sap flows into the plant with equal vigor, but cannot be elaborated because of the removal of the leaves attached to the layer, and consequently it ferments and causes rot in the parent plant.

10. *Propagation by Cuttings.*—Cuttings of from three to five inches in length if planted in beds in the open air and partially shaded will form roots in from three to five months, and when a rapid increase of the plants is not an object, this is perhaps the safest and cheapest plan of propagation; but where the object is to increase the plants rapidly, a propagating house as in Plate II is indispensable; the cost of a structure of the description and size given being from Rupees 800 to Rupees 1,000, where labour and material can be procured at a reasonable price. The plate above referred to gives full particulars of the construction and application of this structure, the fuel used by us being wood; the furnace is however equally well suited for the consumption of peat or coal. With the aid of a propagating house, the youngest wood that can be procured is the best adapted for making cuttings,

as young tender shoots, a fortnight or three weeks old, form roots in a very short space of time; the majority of these cuttings being invariably rooted within a month. It is however difficult to deal with this description of wood, and to secure success requires a great amount of care. The earth in which these cuttings are placed is prepared as before described for the seeds; it is however kept a little drier. The cuttings on being made are placed around the sides of the pots, the cut end of each being pressed firmly on a piece of dry brick, as shown in the illustration in Plate III, Fig 3. Each pot contains from 20 to 25 cuttings, and as they are filled, they are immediately removed to the propagation frames, and plunged into beds of damp sand on a bottom heat of about 75° Fahr.

11. The cuttings are now carefully watched, the surface and the leaves being moistened by a fine syringe when the atmosphere in the frames appears dry; they are however never watered, it being very necessary to ensure success to avoid this, as we have invariably found that when the earth is once watered it causes the cuttings to damp off, and seriously retards their rooting. The cause of this appears to be that the cuttings not only suffer from excess of damp, but when the soil is watered in the usual way after the cuttings are placed in the pots, by its expansion and adhesion from the action of the water, its particles are forced far too close together to be beneficial for the development of roots. With young wood, our losses with cuttings has recently not averaged 3 per cent. In removing the cuttings from the stock plants, one or two pairs of leaves and buds should, if possible, be left between the plant and the part cut; this is done in order not to decrease the succeeding supplies of young wood, which would be the case if the cut was made close to the parent stem. Another circumstance very necessary to be attended to in order to ensure success is to be careful to place each cutting as it is made into the pot with the cut end on a piece of dry brick; this must be attended to, because where the cut is made, the juice begins to flow, and this juice if not immediately absorbed by the dry brick causes mildew and rot. When the cuttings are placed in the frames, they are exposed to as much light as they can bear without flagging.

12. *Propagation by Buds.*—In December last, it occurred to me that the plants could be successfully propagated by leaves with the bud attached; and as this method offered very considerable advantages in producing a large number of plants from a limited supply of wood, we resolved to attempt the experiment, which has been carried out most satisfactorily.

Plate III., fig 4, illustrates the method by which this is accomplished; the whole secret of success depends entirely on the amount of moisture given: if this is supplied in excess, they rot immediately, even in a day; but if sufficient care is exercised, the losses will not exceed 3 or 4 per cent., and this per centage has not been exceeded in many thousands we have propagated in this way. By this method, fine plants are obtained in every respect resembling strong healthy seedlings. The period required to form roots is nearly the same in all the species, varying from three to six weeks. In the figure above mentioned, the pot on the left represents six Cinchona Calisaya buds put in on the 30th January 1862, which were all rooted in 41 days after, being the date on which the drawing was made by Mr. Batcock. The drawing on the right represents a rooted bud of the red bark, put in at the same time. It may be observed, that it is not indispensable that a leaf be attached to the bud; this is no doubt a great advantage, although we have struck many buds without any leaf attached.

13. The usual way in which we prepare the buds is to remove the point of the shoots for a cutting; the stem is then divided near the middle of each internode, split down the centre, and immediately placed upon the brick in the pot: the bud itself being covered with about ¼ inch of soil, while the leaf of course projects above the surface. The pots are then plunged in damp sand and treated in every respect the same as the cuttings.

14. *Nurseries, formation of, in the open air.*—Terraces nearly horizontal (having only sufficient fall on one side to carry off the water) 80 to 100 yards in length, and 7 feet in width, being cut along the face of a hill in a succession of steps, as illustrated in Plate IV, until the number of beds required to form the nursery be obtained, the surface of the beds is then covered with rich vegetable soil from the forest, and dug over to the depth of 18 inches, leaving 15 inches nearest the bank not dug; this undug portion being slightly hollowed out forms a pathway and drain, so as to draw off the rain water, and prevent it from running over the beds. This being completed, forked sticks 3 feet in height above the surface, and 4 feet apart are placed along the front of the beds or terraces; the same description of sticks (but 5 feet in height above the surface) are placed along the back of the beds, or on the outer edge of the pathway, or drain above described. Upon these perpendicular forked sticks, horizontal ones are placed for the support of the thatched hurdles, which are used in covering the beds, while the young plants are being transplanted, and until such time as they have become established; when the hurdles are removed by degrees, by raising them more

and more daily, according as the plants indicate their ability to bear the effects of light and sunshine.

15. The terraces are now again dug over their entire width, with the exception of the pathway, and formed into small beds 5 feet 9 inches in length, and 4 feet wide, with a pathway of 1 foot between each bed; these beds are now ready for the reception of the young plants, which are planted in rows across the bed, 6 inches apart, the plants being 4 inches apart in the row, which gives 110 plants to each small bed, or 10 rows with 11 plants in each; this allows for the spaces lost at the ends and sides of the beds. Of course, the plants in the nurseries require watering, when the weather is dry and even if showery, so long as they are covered with the grass hurdles. In mild showers, it will be found beneficial to the young plants, even if not well established, to remove the grass hurdles while the rain is falling, but they should again be covered immediately the rain ceases.

16. In placing the plants in the nursery beds, it is desirable that a small clump of moss be placed in the rows a few inches under the roots of each plant. The object of the moss being placed under the plants is, to prevent them from suffering when transplanted; as the roots grow into the clump of moss, which enables us to remove the plants with a ball of earth when permanently transplanted into the plantation.

17. *Cultivation.*—The question as to the way in which the land should be prepared for the cultivation of Cinchonas, is one that has been much discussed since the beginning of this experiment; we have advocated that the land should be entirely cleared of forest, at least so much of it as may be planted with Cinchonas. In very exposed situations, or such as are subject to occasional storms and high winds, perhaps it might be well to clear small patches of a few acres in extent here and there throughout the forest, in order to ensure shelter. The only objection to this system exists in the liability of the trees left standing on the borders of the patches to be blown down, and damage the plants within their reach. The system of cultivating the Cinchonas in partially cleared land is liable to the same objection, for the forest trees when deprived of a portion of the support upon which they were accustomed to lean, are also liable to be blown down; and, moreover this system has the further and more serious objections of shading the plants too much from the sun, while they are subjected to the damaging effects of the drip, during the rains, and the roots of the forest trees immediately fill up and choke the holes into which the Cinchona plants are placed,

thus depriving the young plants of all nourishment. In our experiments here, we have planted a considerable extent of land in this way, but I fear with such bad results as will ultimately render it necessary to clear away the remaining forest trees. In the greater part of our operations, the whole of the forest has been felled, and on that which is planted, the growth of the plants has been much more satisfactory than that of those placed under any degree of living shade. I therefore feel convinced that the open system of planting will be the only successful one, especially on the Neilgherries; it is true, that while the plants are young, this system has also disadvantages, which should not be overlooked. I refer to the excessive evaporation and radiation during the bright and cloudless season, when our dry and cold weather prevails. We have hitherto combated this difficulty, by sheltering the plants with a temporary shading of bamboo or fern, as illustrated in Plate V. Many hundreds of our plants however have passed through this dry season without any protection whatever; and, although their growth has not been so rapid, their health is quite equal, if not superior, to any of those protected by artificial shade, and it is probable that during the spring and rainy season the growth will be more rapid in the plants without shade than in those which have been shaded; should this prove to be the case, the system of artificial shading will be abandoned altogether, except when the plants are newly transplanted. With these remarks, which are intended to enable the public to draw their own conclusion, I now proceed to detail the system of cultivation I would recommend.

18. *Cultivation. Preparation of Sites.*—The sites being selected, the operation of felling is begun at the lowest portion of the land, and proceeding with the work upwards, until the whole is completed. Belts of forest may be left upon the ridges, to give shelter; but these must be pretty wide, otherwise they will be destroyed by the fire in burning the fallen forest. After the forest has lain for a sufficient time, to become dry and fit for burning, the afternoon of a dry day with a brisk wind is selected for this operation. A row of coolies being placed about twenty or thirty yards apart across the entire length of forest at its lowest extremity, each provided with a firestick, and a large bundle of dry grass, the grass being carefully placed among the leaves of the fallen trees opposite to each man, at a given signal the whole is set on fire at once, thus immediately generating a force of fire which consumes nearly the whole of the trees, and saves an immense deal of after labor in lopping and burning. By thus firing the forest, a good burn (as planters term it) is almost certain, whereas if the forest is only set on fire in one or two places, it travels comparatively weakly through the trees, consuming only the leaves and

the small branches. The burning being finished, the next operation is to lop and burn such portions as are entangled by the stems of the trees.

19. This operation finished, the lines of road are then marked in such positions, as to render the different parts of the plantation easily accessible. The next operation, is that of lining or marking off the distances at which the plants are to stand apart. For C. Succirubra, C. Calisaya, and the varieties of Grey bark, the lines should be placed 10½ feet apart, and for the varieties of the Crown barks 8 feet apart; this being done, the land is trenched over 3 feet wide, and 2 feet deep, along the lines, and the plants planted in the trenches at 10 feet apart. In placing the plants in the trenches, they should stand alternately, that is, the plants of the second row should be in the centre of the vacancies of the first row. When trenching is considered too expensive, pits may be dug for the reception of the plants, 3 feet square, 2 feet deep, and 10 or 8 feet from centre to centre, according to the species intended to be planted. When filling in the holes, the best surface soil mixed with charcoal and the burned earth is to be selected.

20. *Planting.*—The best season for planting is the early part of the year, or after the ground is well soaked by the first showers; this gives the plants time to be well established before the setting in of the dry weather. Damp, cloudy, or foggy weather, without rain, is the best for planting, and when the soil is comparatively dry, that is, in a state that it will not clog and adhere together, which is the case with all soils, when worked during heavy rains. In placing the plants in the holes, the roots must not be pressed with the hand, as this invariably causes decay; six to eight plants being taken from the nursery at a time, are placed in a basket, and conveyed to the planter, who raising the plant from the basket between the thumb and forefinger of the left hand, while with the right hand he supports the ball of earth, at the same time conveying the plant to the hole made for its reception, where being deposited, the loose earth is filled in lightly around the roots, and the plant shaded by a few palm or fern leaves. If the weather continue dry, the plants should be watered in the mornings or evenings, until they become established. It may here be observed, that no plant should ever be watered while the sun is shining upon it, as every globule of water forms a lens, which burns up the portion of the leaf on which it rests; neither should any plant be buried deeper in the ground than the collar, or union of the stem and roots. When a portion of the stem is buried in transplanting, the growth of the plant is much retarded, and it does not, as some suppose, give it a firmer hold of the ground, but the reverse. When manure

can be obtained, its application will be found to be highly beneficial, as Cinchona plants like the Coffee delight in a good soil well enriched by manure. If used too fresh, the application of manure might prove injurious; it is, therefore, always safest to apply such manure only as is well decomposed. When the planting is finished, the young plants must be carefully attended to until such time as they become established; should the weather prove wet with high gales of wind, the fern or date leaves used for shading should be removed to such a distance as not to touch or rub upon the plant when moved by the action of the wind. When it is necessary to stake young plants in order to give them support, two stakes should be used, being driven into the ground opposite to each other at from a foot to eighteen inches from the stem of the plant, then around these stakes, and passing from the one to the other, a piece of coir rope is stretched in a double line enclosing the plant, the point where the ropes pass the stem of the plant being secured against rubbing, by a clump of soft moss being wrapped round it. The plants being once fairly established, the plantations like those of Coffee will merely require to be occasionally weeded, and the surface turned over from time to time, in order to permit of the action of the atmosphere upon the soil.

21. It may be expected of us to answer the very natural, and probably the first, question which will arise in the mind of every planter, namely, "How will Cinchona cultivation pay?" Although we have not yet practically answered this question, I feel called upon to contradict a very erroneous notion which has been extensively propagated, that "Cinchona trees will not produce bark under forty or fifty years." It is not desirable to be over sanguine as to the produce to be obtained from any new cultivation, but still the advantages which the Cinchonas offer should be taken fairly into consideration. In the early part of this experiment, it occurred to me that a small produce might be obtained in the sixth or seventh year after planting; but since that time, I have reason to believe that a small harvest of bark will be procured even earlier, and that Cinchonas will not be far behind Coffee or Tea in the period which must elapse between the time of planting and that of reaping the first harvest. This opinion has been considerably strengthened by the analysis of Mr. Howard, noted at foot,*

* "The piece of Bark you sent me from India is, so far, a very promising earnest of "much that is to follow, as we hope, in good time. I have examined it both chemically "and microscopically, as far as so small a piece would enable me so to do, and I am happy "to say the result is so far satisfactory. The test of sublimation, shows abundance of the "distinctive carmine color indicating Alkaloid, and the Section shows under the micros- "cope the commencement of the chief tissues; the suberous tissues well developed, as in "Red Bark, generally the cellular tissues, cortical fibre, medullary rays, &c."

(Signed) J. E. HOWARD.

of a small portion of young bark grown on the Neilgherries; this bark was forwarded in July last, or fifteen months after the receipt of the first Cinchona plant in India, a portion of the bark being from wood of only eight months growth. Another serious objection urged against the profitable cultivation of Cinchonas is the supposed necessity of felling the trees in order to procure the produce, because this has been usually done on the Andes. There can however be no doubt that such a system can never be put into operation with plants under cultivation; as the opinion which we at first advanced has already been well confirmed, namely, that constant and uniform yearly supplies of bark can be obtained by simply lopping and pruning the trees; and as this operation if conducted with skill will benefit rather than injure the plants, there can be no doubt that it will be uniformly adopted. Plate VI gives a general idea of the principle of lopping and pruning recommended. The plants should be induced to branch as near the ground as possible, and in the fifth year, the two branches are removed at the line A A; the branches below, marked B B, would immediately take their place, preserving the uniform growth and appearance of the trees. In the sixth year, the branches at the line C C would be cut off in like manner, the small branches marked D D, being left to take their place; and this operation should be continued on successive branches, until the eighth or ninth year, by which time the branches marked B B could again be removed, and so on for any number of years. Judging from the growth the plants have attained here, it would not be too much to estimate 1 lb. of bark from each tree as the produce of the first pruning, or 500 lbs. per acre; but reducing this estimate to one-half, or 250 lbs. of bark per acre, as the average produce from the fourth to the eighth year, after this date a rapidly increasing supply would be obtained as the trees gain size; and with this yearly produce, an amount of bark will be annually stored up in the trunk to be made available at a future date, perhaps 40 or 50 years, when the entire tree might be felled; but a year prior to the operation of felling, a triangular incision of 2 inches each way should be made entirely through the bark, and the piece of bark removed as illustrated in Plate VI, Fig 3. This would cause the development of buds at E, and a number of young shoots would immediately spring from the base of the triangular incision as illustrated in Fig. 2. F.; when these shoots have attained a height of 3 to 4 feet or more, the trunk may be felled immediately above them, one of the finest shoots on each side being selected to take its place, and the small shoots removed. The average yield of large trees of the C. Succirubra is estimated at 500 lbs. of dry bark.

22. There is another advantage possessed by Cinchonas over every other cultivation, that is the great difference between the market value of the produce and the cost of production. This state of the market has been brought about by the supplies of bark from the South American forests yearly decreasing, while the demand for this inestimable medicine is increasing, and its application in discases extending. The average market price of Peruvian bark produced by the best species may at present be estimated at from five to six shillings per pound of dry Bark, while judging from the progress our plants have made here, the cost of production of this quantity of bark cannot possibly exceed threepence.

23. The following brief notice of the different species of Cinchonas introduced, will enable intending purchasers to select such as may be best suited to their localities.

Cinchonas yielding Quinine.

Cinchona Succirubra, the "Cascarilla colorada" or "Genuine Red Bark" of commerce. This species grows to a lofty tree, and is the most valuable known, being the richest in alkaloids, which generally amount to as much as 3 to 4 per cent., and thus "fair average samples are valued in the market at more than twice the price of Calisaya Bark." The present price of Red Bark varies from 2*s.* 6*d.* to 8*s.* 9*d.* per pound of dry Bark. This sort is also hardy, its range of growth extending from 3,000 to 8,000 feet; the plant, according to Mr. Spruce, prefers open ground with "plenty of air, light, "and room, wherein to develope its proportions, the Bark is thin in pro-"portion to the diameter of the trees when growing at low elevations, and "thick in proportion when growing at high elevations." The amount of "alkaloids is also much affected by elevation. Mr. Spruce informs us that "Senor Cordovez (who has analysed the Red Bark, collected at various alti-"tudes) found that the greater the height at which the tree grows, the larger "is the proportion of alkaloids contained in the Bark."

Cinchona Calisaya, or "Yellow Bark of Bolivia." This species grows to the height of a large forest tree, and was long considered the most valuable of all the medicinal Barks; and certainly it was so, until the discovery of the Red Bark; the present price of Calisaya or Yellow Bark, varies from 2*s.* 10*d.* to 7*s.* per lb. Of this species we have evidently two varieties very distinctly marked, even when growing under the same conditions. According to Mr. Markham and Dr. Weddell, "the tree Calisaya grows on declivities "and steep rugged places of the mountains 5,000 to 6,000 feet above the "sea, in the hottest forests of Caravaya and Bolivia." Subsequently,

Mr. Markham in writing of this species states ; " There can be no doubt that " the correct method of cultivating the Cinchonas is planting them out, in the " open, with plenty of light and air. They may require shade from the " direct rays of the sun at first. The only really fine well grown plant of " Cinchona Calisaya that I saw in Caravaya was one that had been planted " in a small clearing entirely exposed ; those in the forest were poor straggling " things in comparison."

Cinchona Uritusinga, the "Cascarilla fina" or " Original Loxa Bark" introduced by J. E. Howard, Esq. This species, which in the days of La Condamine was a noble and lofty forest tree, is now almost extinct, the trees of a large size having entirely disappeared from the Andes ; it is rich in alkaloids, good specimens giving a total of 3·8 per cent., and in this respect it equals the Calisaya Bark of Bolivia ; it was common on the mountains of Uritusinga, and grows at elevations from 6,000 to 8,000 feet. A general opinion prevails among the Cascarilleros that the Bark of this species " differs in quality according as it is exposed to the morning or evening sun."

Cinchona Condaminea, the "Cascarilla Colorada del Ray" or " Cascarilla Amarilla," the "Rusty Crown Bark" of English commerce and of equal value to the preceding species, to which it is nearly allied, inhabiting the same localities, but perhaps growing at greater elevations. In the days of Pavon, this was a slender tree of little more than 24 feet in height, and is considered to be the species that produced the Bark which cured the Countess of Cinchon. At the present time, Mr. Cross informs us, " but few trees are to " be seen of these dimensions. The plants from which the bark of commerce " is now taken are in general not more than eight to ten feet in height. " When the plants are cut down three or four young shoots, or suckers in " general spring up ; but this does not always happen, as some of the more " industrious Cascarilleros frequently pull up the roots, and bark them also. " The Bark is taken from the smallest twigs, thus the annual growths are " sometimes taken, especially if they are strong. Mr. Cross also observes " that the alluvial deposit in the ravines where this species is found growing, " is shallow and in many places not more than six inches in depth."

Cinchona Crespilla (C. Crispa Tafalla), or " fine Crown Bark." This species is a small shrub, and contains a smaller quantity of alkaloids than the preceding ; still it brings a high price in the market, being a " very fragrant and pretty looking Bark." It grows at great elevations (from 7,000 to 10,000 feet) in a deposit of peat, and where the temperature sometimes falls to 27 ° Fahr.

Cinchona Lancifolia from Java or "Pataya Bark." This is a valuable species, it is also hardy and easily cultivated, inhabiting the high and cold regions of the Andes. Dr. Karsten observes that, "it descends only to a height of 2,000 metres (6,170 feet) above the sea, from the cold summits of the mostly snow-capped mountains, where it sometimes reaches the upper limits of the growth of trees, that is 3,500 metres, (10,797 feet.) Mr. Howard observes that this species produces a Bark which rivals in their rich product of Quinine, the Barks of Bolivia, and consequently commands a very high price."

Cinchonas yielding Cinchonine.

24. Cinchona Nitida, "Quina cana legitima," or "Genuine Grey Bark." This is a lofty tree, abounding in the higher regions of Huanuco ; its predominant alkaloid is Cinchonine, and is consequently of less value than the preceding species, which belong to the class yielding Quinine : the analysis of the Bark from which our seeds were gathered gave 2·22 per cent. of alkaloids, consisting chiefly of Cinchonine ; Mr. Howard has however found Quinine in samples of the fine Grey Barks of commerce. This species grows in exposed places at elevations from 6,000 to 8,000 feet, and is said to delight in "free air, cold, water, and sunshine."

Cinchona, species without name. Allied to the above, and raised from seeds gathered by Mr. Pritchett, near Huanuco. Mr. Howard is of opinion that this species may prove to be identical with Cinchona Obovata of Pavon. It is said to be a "good Bark," and extensively imported with the Grey Bark of commerce.

Cinchona Micrantha, the "Cascarilla Provinciana" or "Grey Bark." This is a lofty tree, inhabiting warm and damp forests, where it attains a great circumference ; one tree frequently yielding from 200 to 250 lbs. of dry Bark. The Bark is generally rich in Alkaloids, yielding as much as 2·70 per cent. principally consisting of Cinchonine.

Cinchona Peruviana, the "Cascarilla Pata de Gallinaza," or "finest Grey Bark." This species attains the height of an ordinary sized tree in the forest of Cocheros, where it is still abundant, growing at a lower elevation than Cinchona Nitida, and yields a Bark of considerable value ; the Bark of the trees our seeds were collected from when analysed by Mr. Howard, yielded 3 per cent. of Alkaloids, comprising chiefly "Cinchonidine and Cinchonine." It thus ranks among the most valuable of the Grey Barks.

In concluding this brief manual, I would refer the reader for further information to Mr. Howard's superb work on Cinchonas, entitled "Illustra-

tions of the Nueva Quinologia of Pavon," and for detailed information on the subject, to the able work of Clement R. Markham, Esq. of the India House, entitled "Travels in Peru and India," recently published by Mr. J. Murray, Albemarle Street, London.

Transmission of Plants.

25. In the usual way of packing plants in Wardian cases, their transmission to a distance was most expensive and uncertain. To find a system which would obviate the risk, and reduce the cost of transit has formed a subject of recent experiments. The issue of these, I believe, justifies us in recommending to the public, the following method of packing Wardian cases, by which the cost of transit is reduced to less than one-sixth, and which secures greater safety in conveyance, inasmuch as the plants are less liable to damp off from an excess of moisture, while it secures the great advantage of reducing the weight of the cases to about one-fifth, thus rendering the cases more easily handled, and less liable to damage in being removed.

The Wardian cases for packing the plants can be supplied here at a cost of Rupees 15 each, one case containing from 170 to 220 plants, according to the species; instead of 28 or 30 plants, as formerly used to be packed in cases of the same size. In the system of packing which I now recommend, the Wardian cases are filled with moss instead of earth, to a depth of about 6 inches, and the Cinchona plants in the pots in which they were grown are firmly packed in the moss, and secured with cross battens, in order to prevent them being displaced should the cases be upset in transit. When the plants are thus secured, they receive a moderate amount of water; the sashes are then screwed on, the glass being protected by battens, and secured from the direct rays of the sun by a covering of thin cloth, so as to admit a portion of the light. In this way, the plants can safely be conveyed to Calcutta or Ceylon without the cases being opened; but where the journey is likely to be prolonged over a month, the cases should be opened mornings and evenings, so as to admit of the plant receiving light and air, water being added only when the surface of the earth in the pots is dry.

The cost of the conveyance to Madras of a case the weight above described is about Rupees 6, and the freight to Calcutta or Ceylon about Rupees 16.

Plants can be conveyed to a short distance (less than 80 miles), with perfect safety, packed in open baskets; about 50 plants forming a cooly load.

W. G. McIVOR,

Superintendent Government Cinchona Plantations.

PLATE I.

PROPAGATION BY LAYERS.

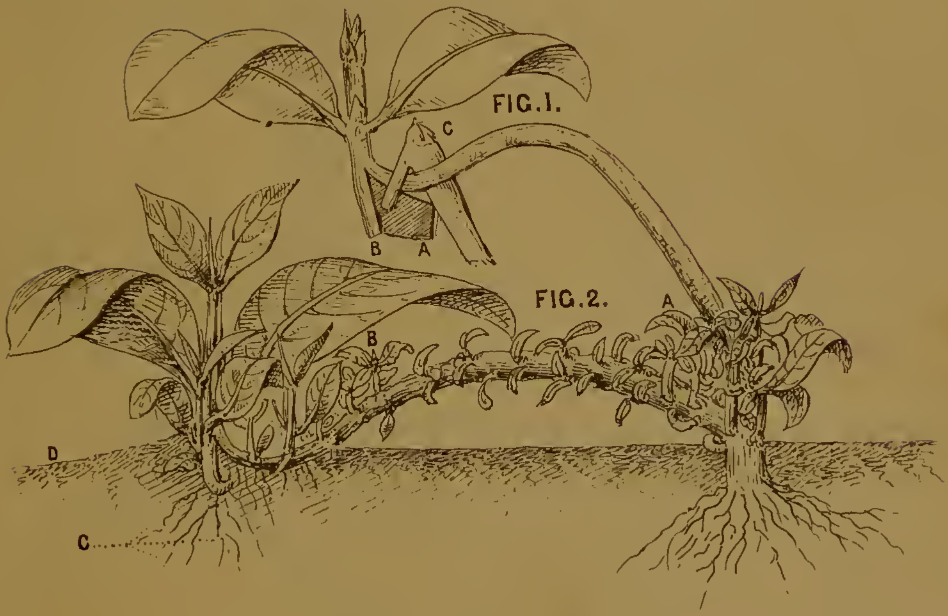

FIG. 1. *Layer as prepared for laying down.* — A, *the piece of Brick.* B, *the tongue.* C, *the peg.*

FIG. 2. *Represents the same plant, six weeks after being laid,* C, *the rootlets,* D, *the surface of the soil.*

PLATE II.

PLAN OF A PROPAGATING HOUSE.

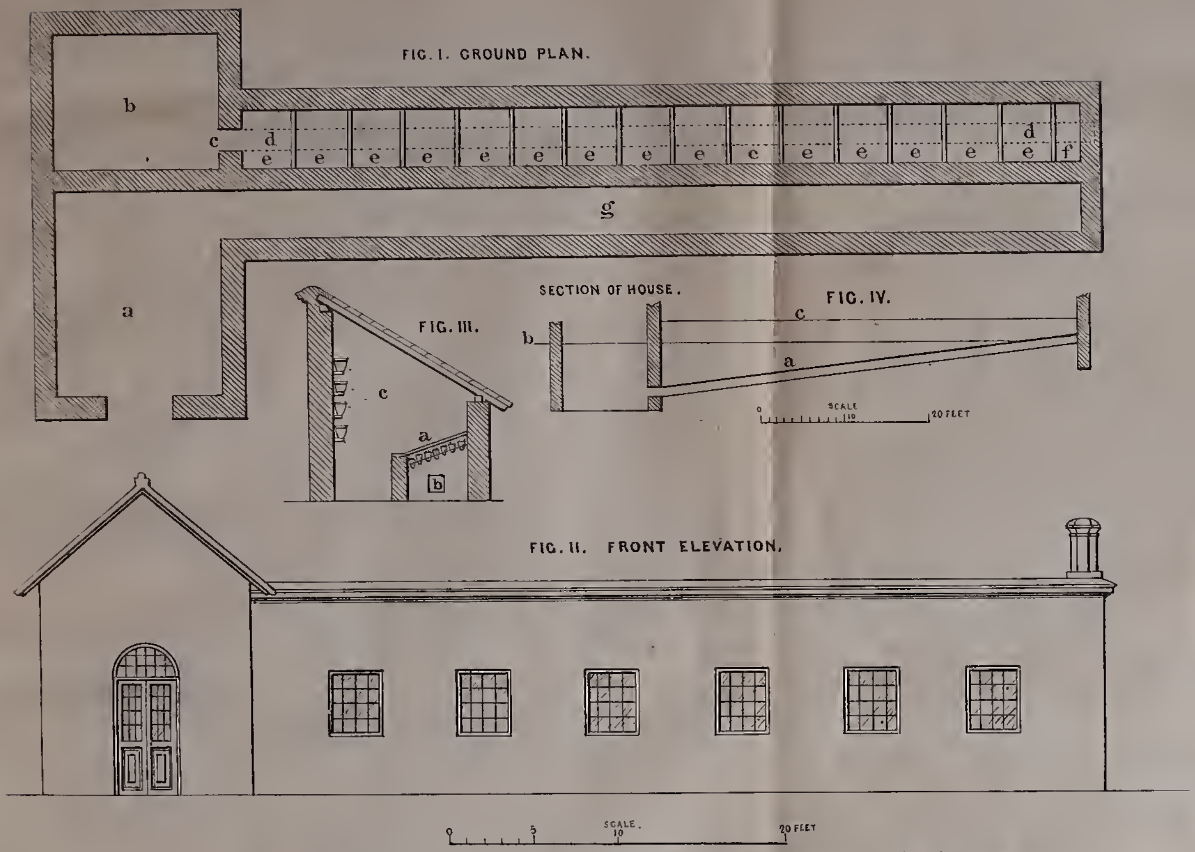

FIG. I. – a, *potting shed*. b, *furnace house*. c, *fire place*. d, *flue*. e, *the propagating cases*. f, *the cistern placed over the flue so that the water may become slightly heated*. g, *path*.

FIG. III. – a, *the cases filled with pots*. b, *the flue*. c, *shelves attached to the spaces of wall between and below the windows*.

FIG. IV. – *shows the gradual rise of flue in the beds* – a, *the flue* – b, *level of ground* – c, *the level of the beds*.

PLATE III.

PROPAGATION BY CUTTINGS AND BUDS.

FIG. 4.

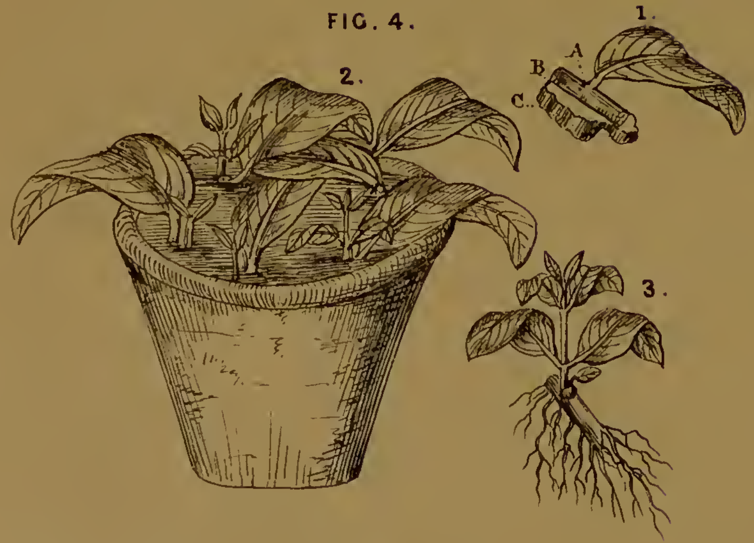

FIG. 3.

FIG. 4. 1. *Represents the bud A, prepared for placing in the pot, shewing the cut part B, upon the brick C.*
2. *A pot of buds of Cinchona Calisaya 41 days after planting.*
3. *A bud of Cinchona succirubra also 41 days after planting.*

FIG. 3, *Shewing cuttings as placed in the pots with the ends on a piece of dry brick: A, the brick; B, the soil; C, moss; D, potsherds.*

PLATE IV.

FORMATION OF NURSERY BEDS.

FIG. 1.

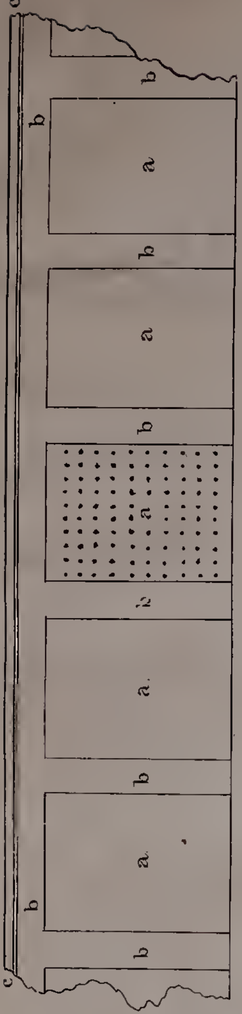

FIG. 2.

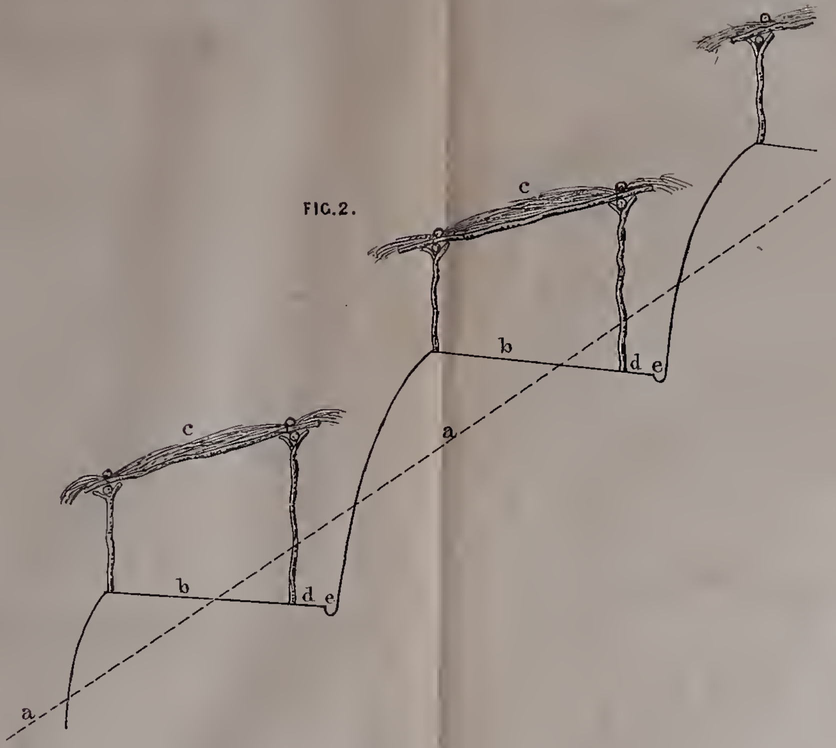

FIG. 1. *Ground Plan of Beds:* a, *the beds;* b, *the paths;* c, *the drain.*
FIG. 2. *Section of Terraces:* a, *original surface of the hill;* b, *beds;* c, *thatched hurdles;* d, *paths;* e, *drain.*

PLATE V.

TEMPORARY SHADING.

FIG. 5.

Represents the manner in which the dead shade of Bamboos &c.ª is applied, the open space being on the North side. A, the Bamboo; B, the plant; C, the dead leaves, D the ground.

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PLATE VI.

ILLUSTRATING THE SYSTEM OF

LOPPING AND PRUNING RECOMMENDED.

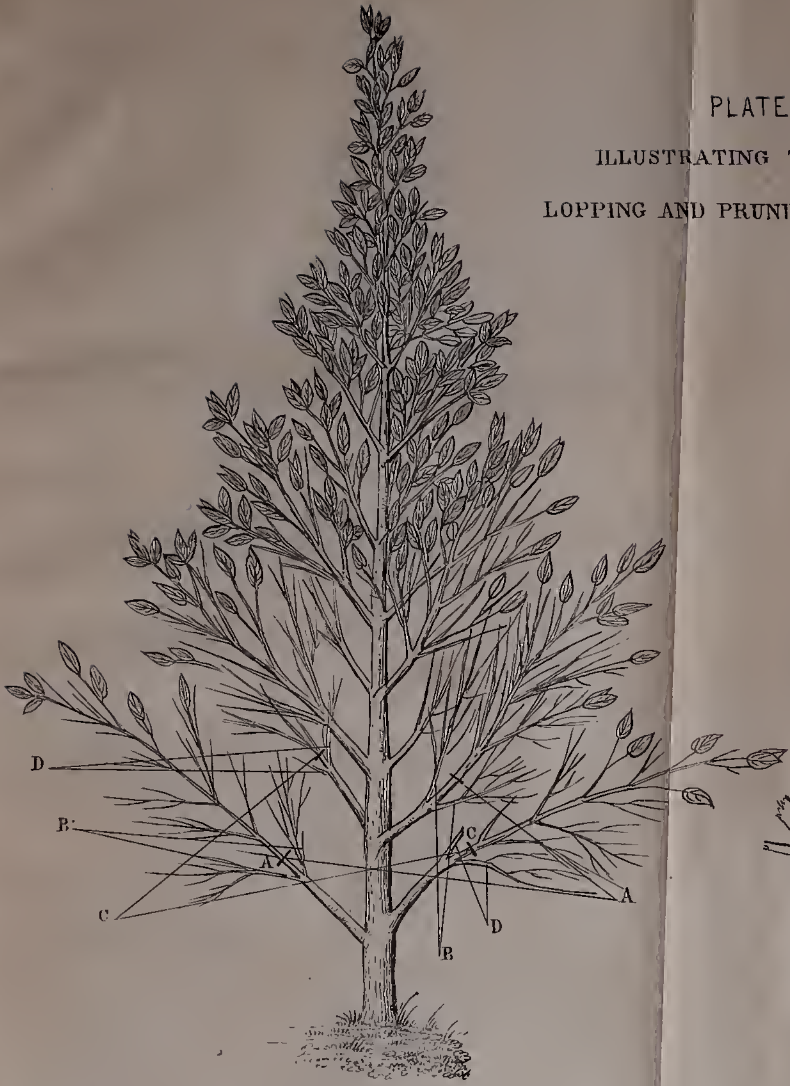

FIG. 1.

FIG. 2.

FIG. 3.

The two branches at A, A, being removed for their bark on the fifth year, the branches at B, B, take their place; in like manner the branches at C, C, are removed on the sixth year, while D, D, take their place.

Report on the number, distribution, and condition of Cinchona plants, on the Neilgherries, on the 28th February 1863.

No. of species.	Botanical names.	Commercial names.	No. of plants.	Value per lb. of Dry Bark in the London Market.
				s. d. *s. d.*
1	C. Succirubra	Red Bark	48,989	2 6 to 8 9
2	C. Calisaya...	Yellow Bark	1,480	2 10 to 7 0
3	C. Uritusinga	Original Loxa Bark. ...	927	2 10 to 7 0
4	C. Condaminea	Select Crown Bark.. ..	61,012	2 10 to 7 0
5	C. Crespilla..	Fine Crown Bark.... ..	825	2 10 to 6 0
6	C. Lancifolia	Pitaya Bark	1	1 8 to 2 10
7	C. Nitida	Genuine Grey Bark. ..	8,312	1 8 to 2 9
8	C. Species without name.	Fine Grey Bark	2,595	1 8 to 2 10
9	C. Micrantha	Grey Bark.	8,326	1 8 to 2 9
10	C. Peruviana	Finest Grey Bark... ...	2,847	1 8 to 2 10
11	C. Pahudiana	Unknown..	425	Worthless.
		Total number of plants......	1,35,739	

TABLE II.—Memorandum of the growth of eleven plants of C. Succirubra, planted on the 2nd Denison Plantation at Neddivuttum, on the 30th August 1862.

No. of plants.	Height in inches on the 30th August 1862.	Height in inches on the 31st January 1863.	Height in inches on the 28th February 1863.	Growth in inches during February 1863.	By whom planted.
No. 1	23	45	48	3	His Excellency Sir W. Denison.
,, 2	16½	40	44	4	
,, 3	19	38	41	3	
,, 4	15	40	43	3	
,, 5	27	52	54	2	
,, 6	20	41	43	2½	
No. 7	21	41	44½	3½	J. W. Breeks, Esq.
,, 8	18	40	44	4	Dr. Sauderson.
,, 9	20	40	42	2	J. D. Sim, Esq.
,, 10	20	48	51	3	Lieutenant McLeod.
,, 11	18	46	52	6	P. Grant, Esq.

Remarks.

1. The total number of plants planted out permanently in the plantations, remain as formerly, namely 35,000. These plants have now passed through the dry and cold season in the most satisfactory manner; the weather now becoming mild with appearance of rain, indicating the close of the winter season.

2. The increase by propagation during last month is 8,068, being about 3,500 plants under the average results of the last six months, this reduction being caused by the want of space to harden off the plants.

3. Table II exhibits the growth of eleven plants planted out by His Excellency the Governor, and other gentlemen on the 30th August 1862. The average growth of these plants, during last month being 3¼ inches, or a quarter of an inch less than in January, which allowing for the shortness of the month of February, gives merely the same results. The height of the largest plant we possess is now 7 feet two inches, with branches from 3 to 5¼ feet in length. The stem, measured half a foot from the ground, is 5⅘ths of an inch in circumference.

GOVERNMENT GARDENS,
Ootacamund.
6th March 1863.

(Signed) W. G. McIVOR,
Superintendent Government Cinchona Plantations.